

Sea-Level Change Planning and Adaptation: USACE and DoD Perspective

**Workshop on Planning and Engineering Climate
Resilient Infrastructure at NASA Coastal Facilities**

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Workshop Questions

- **What are the risks?**
- **Master planning: best practices and lessons learned**
- **Common adaptation approaches**
- **How to prioritize activities**
- **Design and construction: best practices and lessons learned**
 - **Regulatory codes and design standards**
 - **Sustainable design practices**

Workshop Questions

(continued)

- **O&M: best practices and lessons learned**
- **Being better prepared: before, during, and after**
- **Maintaining momentum**
- **Measuring success**

My Focus for Today

- What are the risks?
- Approaches
- Prioritization
- Design and construction
 - Regulatory authority
 - Design standards
 - Sustainable design considerations
- O&M
- Maintaining momentum

USACE and DoD

current interests and activities

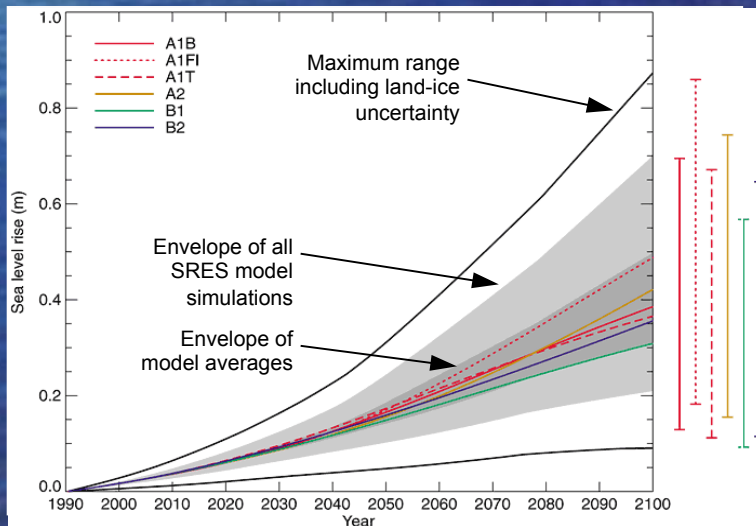
- **USACE policy**
- **USACE interest & actions**
- **DoD interest and actions**

The background of the slide is a photograph of a vast, deep blue ocean. The water has a textured surface with small, gentle ripples. In the distance, a thin, white layer of clouds is visible along the horizon line, separating the dark blue water from a lighter blue sky.

What are the Risks?

What are the Risks? future sea-level change

IPCC: TAR, AR4, AR5 (future projections?)



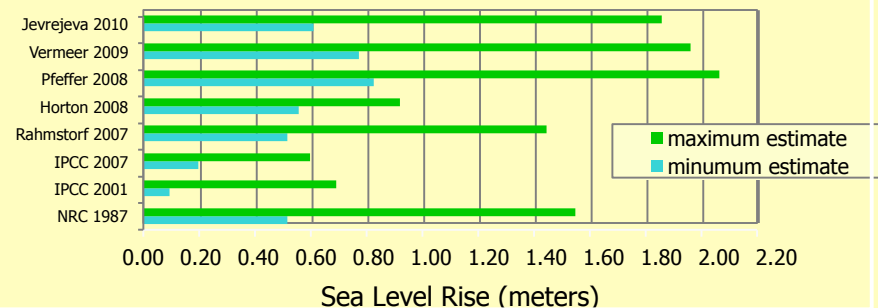
IPCC, 2001

Case	Temperature Change (°C at 2090-2099 relative to 1980-1999) ^a		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	Likely range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations ^b	0.6	0.3 – 0.9	NA
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Table notes:
^a These estimates are assessed from a hierarchy of models that encompass a simple climate model, several Earth Models of Intermediate Complexity (EMICs), and a large number of Atmosphere-Ocean Global Circulation Models (AOGCMs).
^b Year 2000 constant composition is derived from AOGCMs only.

IPCC, 2007

Comparison of Peer-reviewed Research Estimates: Global Sea Level Rise by 2100



Recent Literature

What are the Risks?

Future Projections of (Global) Sea-Level Change

- **Intergovernmental Panel on Climate Change (IPCC)**
- **National Research Council**
- **Various individuals**
- **U.S. Global Change Research Program (USGCRP) - National Climate Assessment (NCA)**

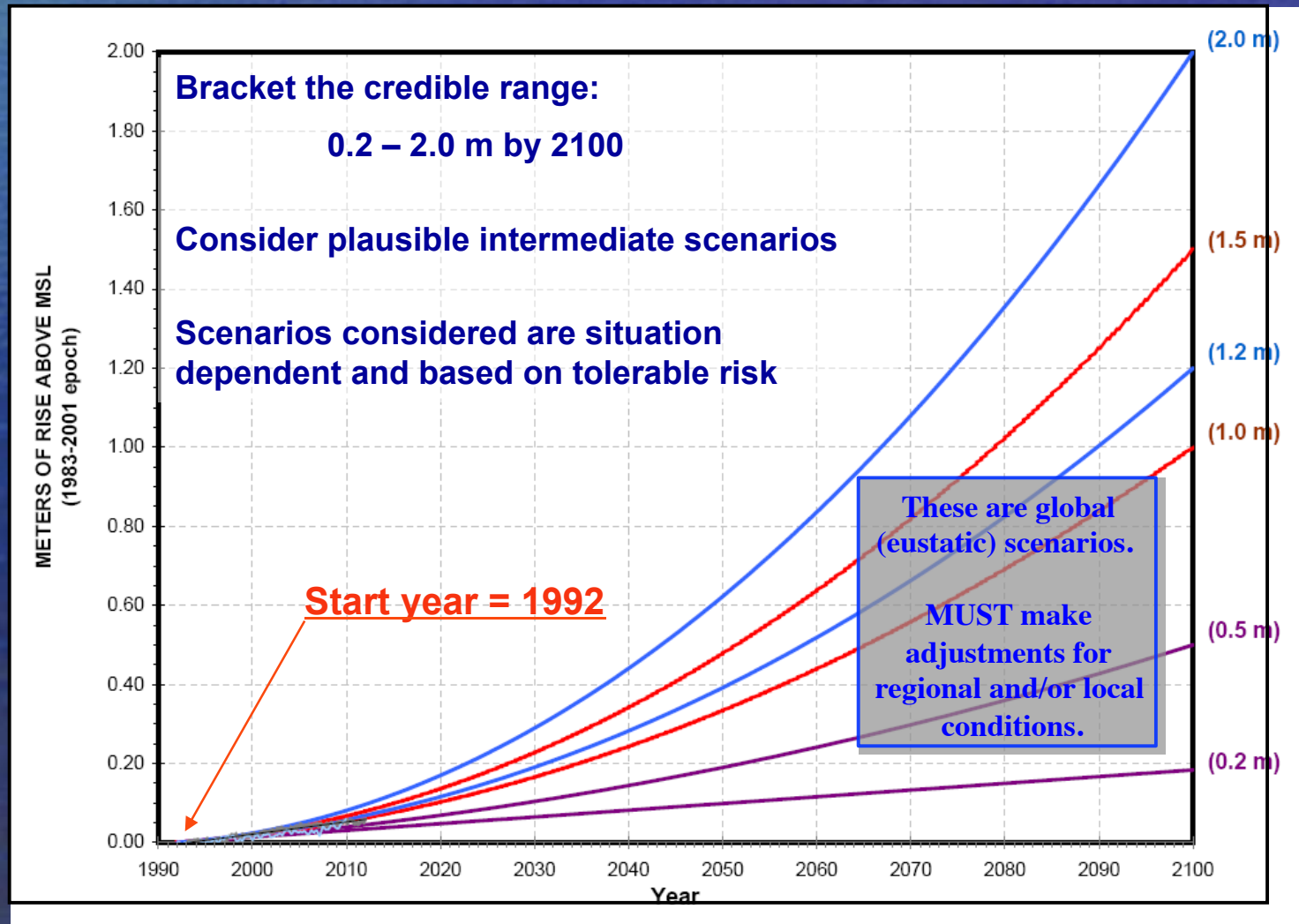
What are the Risks?
future sea-level change

**We cannot predict the
future so what should
we do regarding sea-
level change?**

What are the Risks?

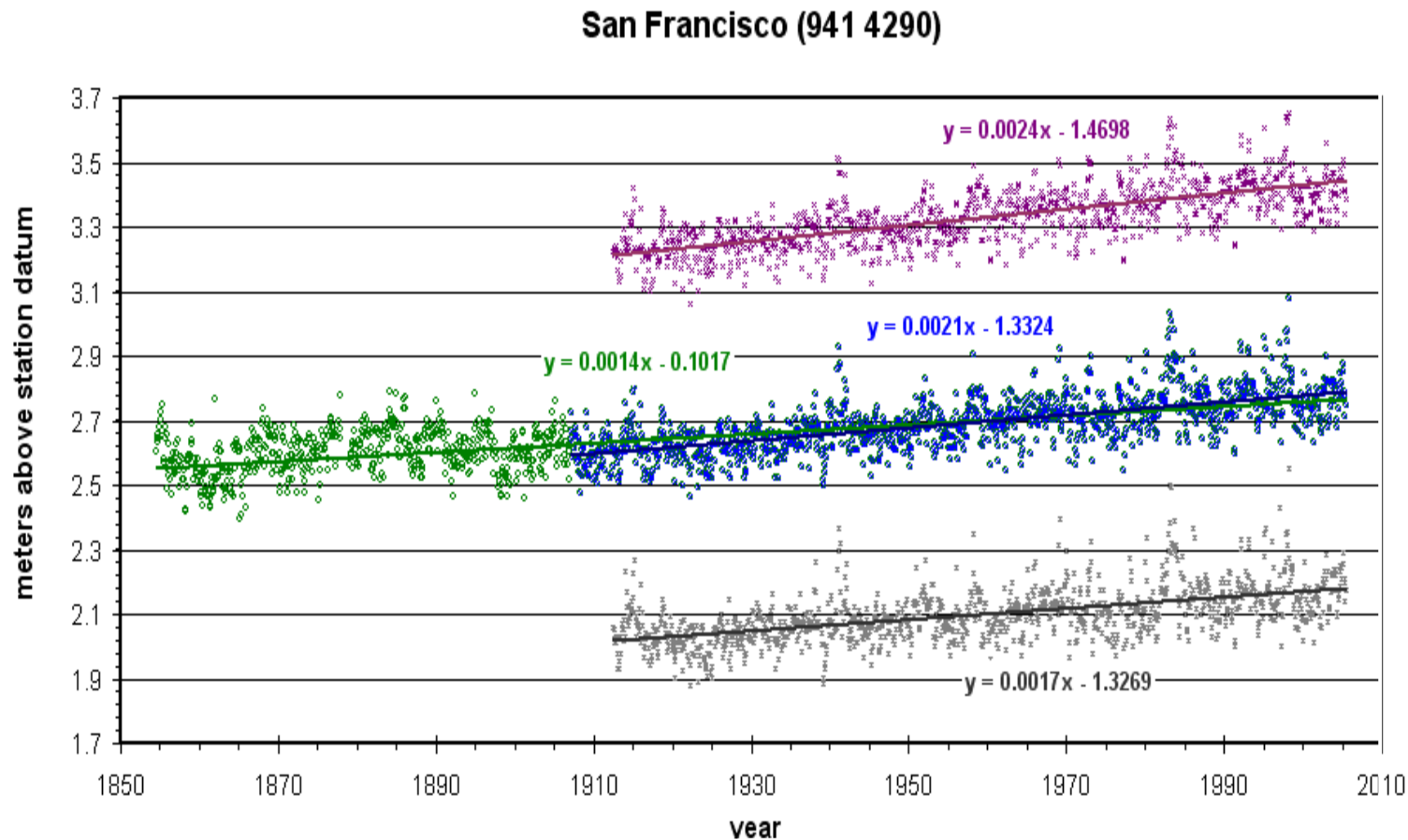
Future Projections:

Multi-Scenario Approach - Plan for Uncertainty



What are the Risks?

Future Projections: MSL vs Other Considerations



LMSL Trend

duration

0.0014 m/yr or
0.46 ft/century

Post-eq

0.0021 m/yr or
0.69 ft/century

MHW Trend

0.0024 m/yr or
0.79 ft/century

MTR Trend

increasing

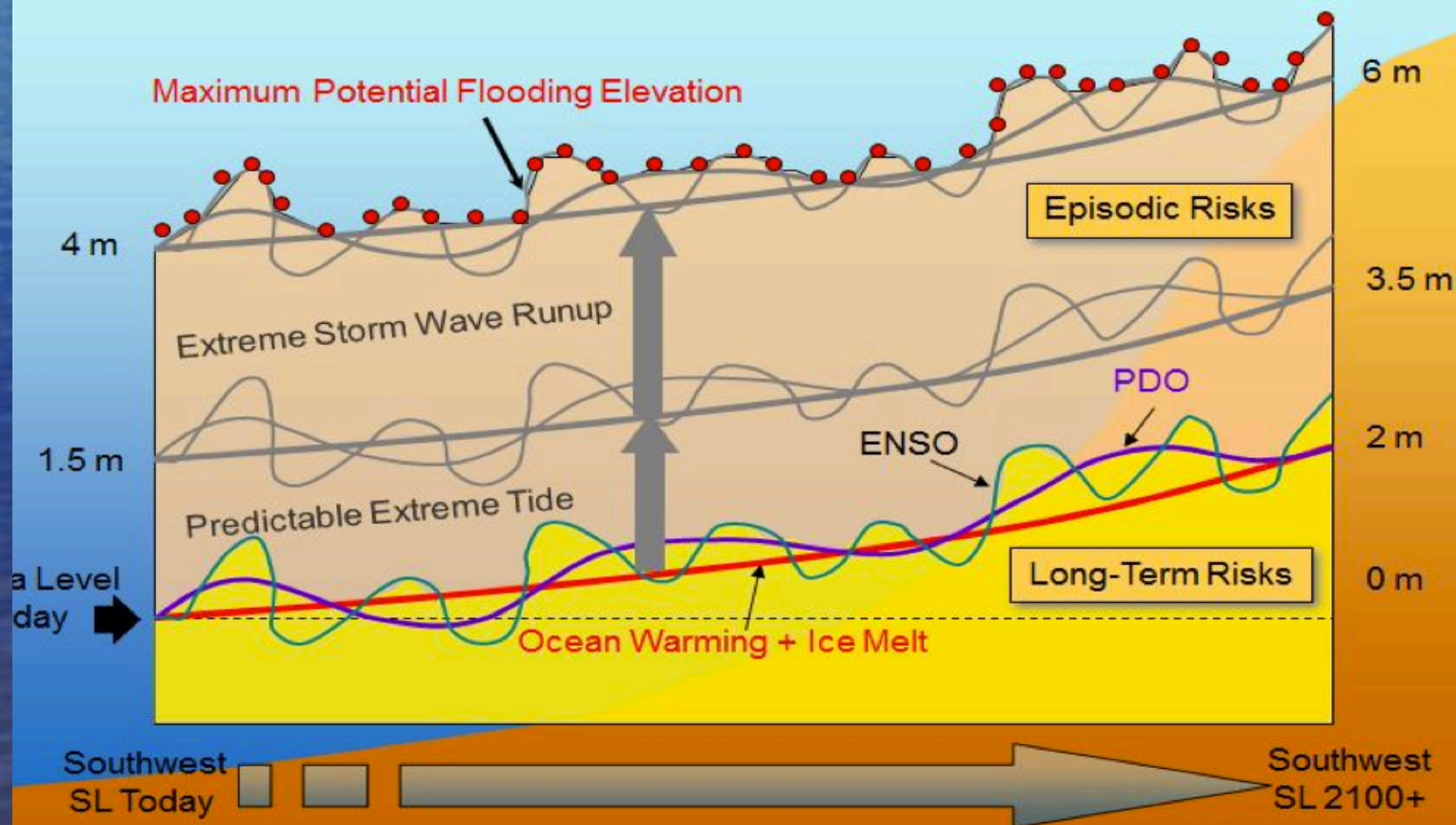
What are the Risks?

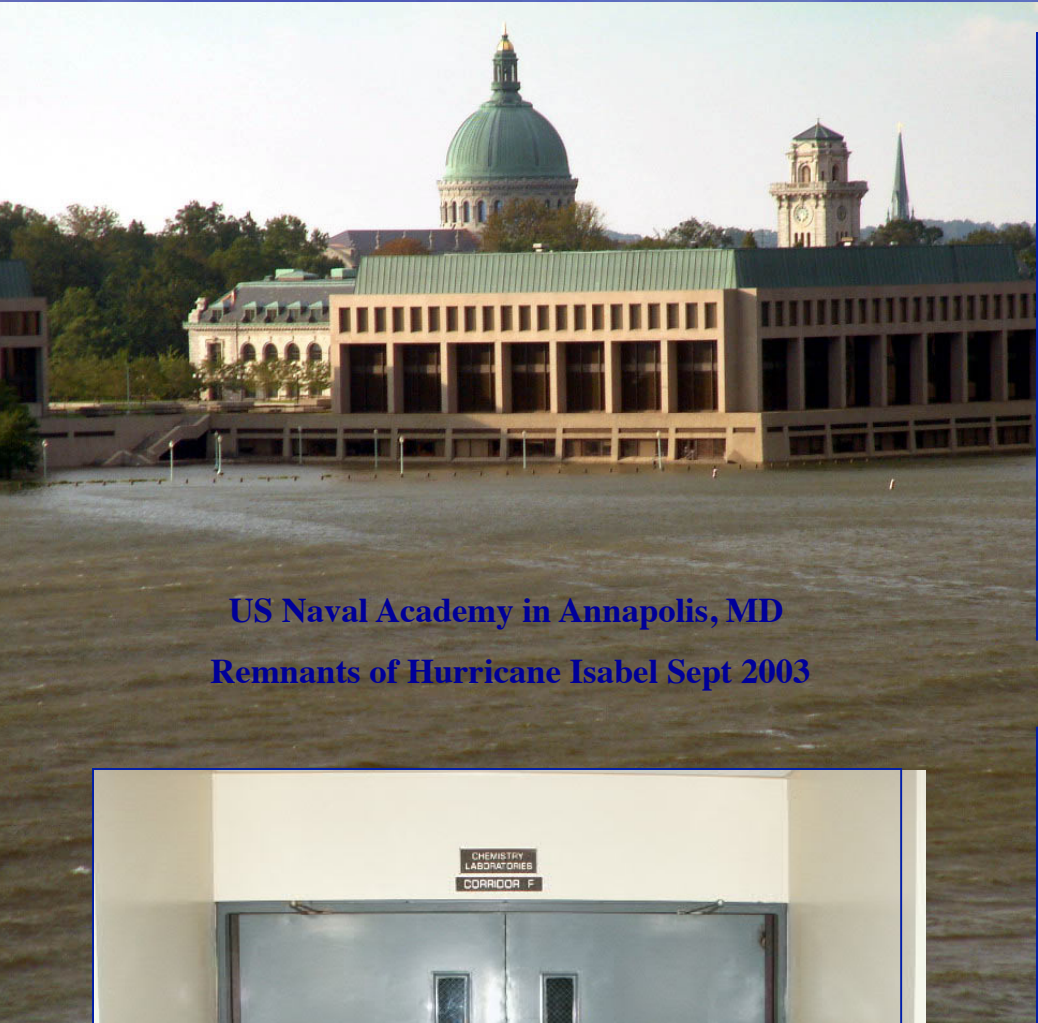
MSL vs Other Considerations

Represent the source term for the assessment

Prescribed scenarios, historical trends, & modeled projections

Combinations of MSLR, Climate Variability, Tides, Waves & Runup





US Naval Academy in Annapolis, MD
Remnants of Hurricane Isabel Sept 2003



**What will a future flood look like
with additional sea level rise?**

From Dave Kriebel, USNA



Approaches & Prioritization

Approaches

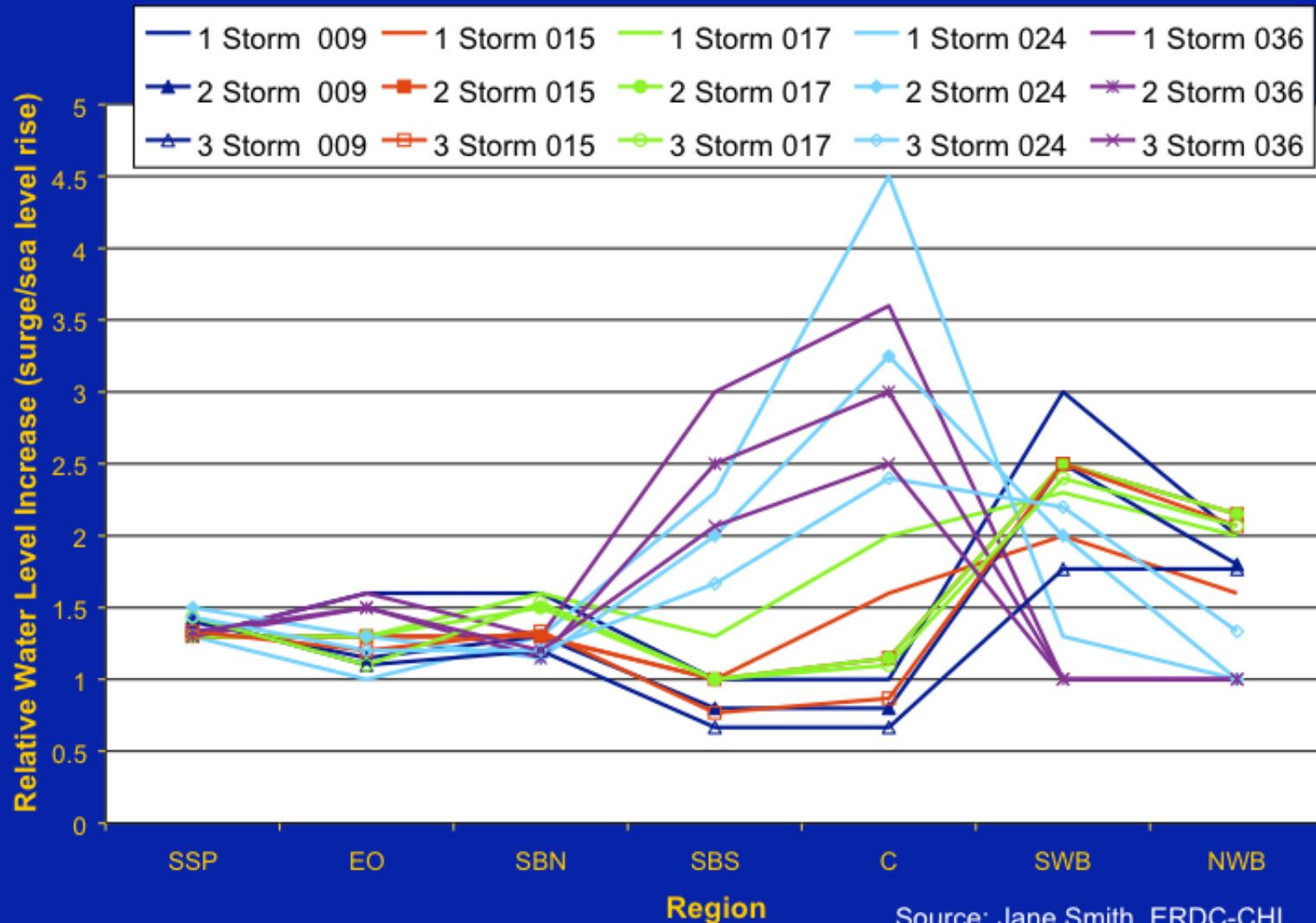
- **Screening-level assessment**
- **Rigorous assessment**

Prioritization

- Experience from dam safety
- Based on screening-level assessment
- Requires consideration of relative importance of certain aspects of the technical analysis

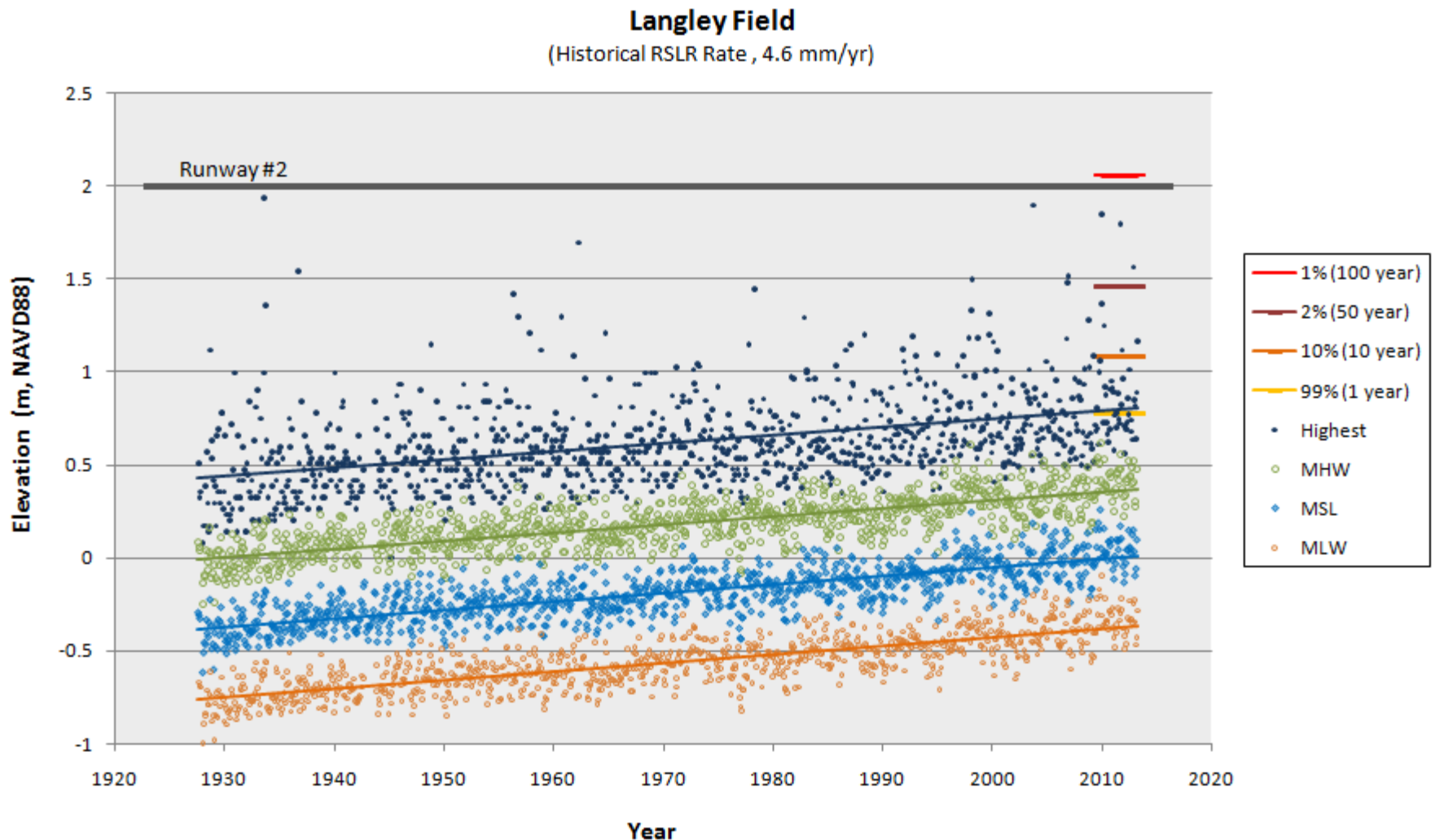
Prioritization

Screening-Level Assessment: SLR Effects on Storm Surge

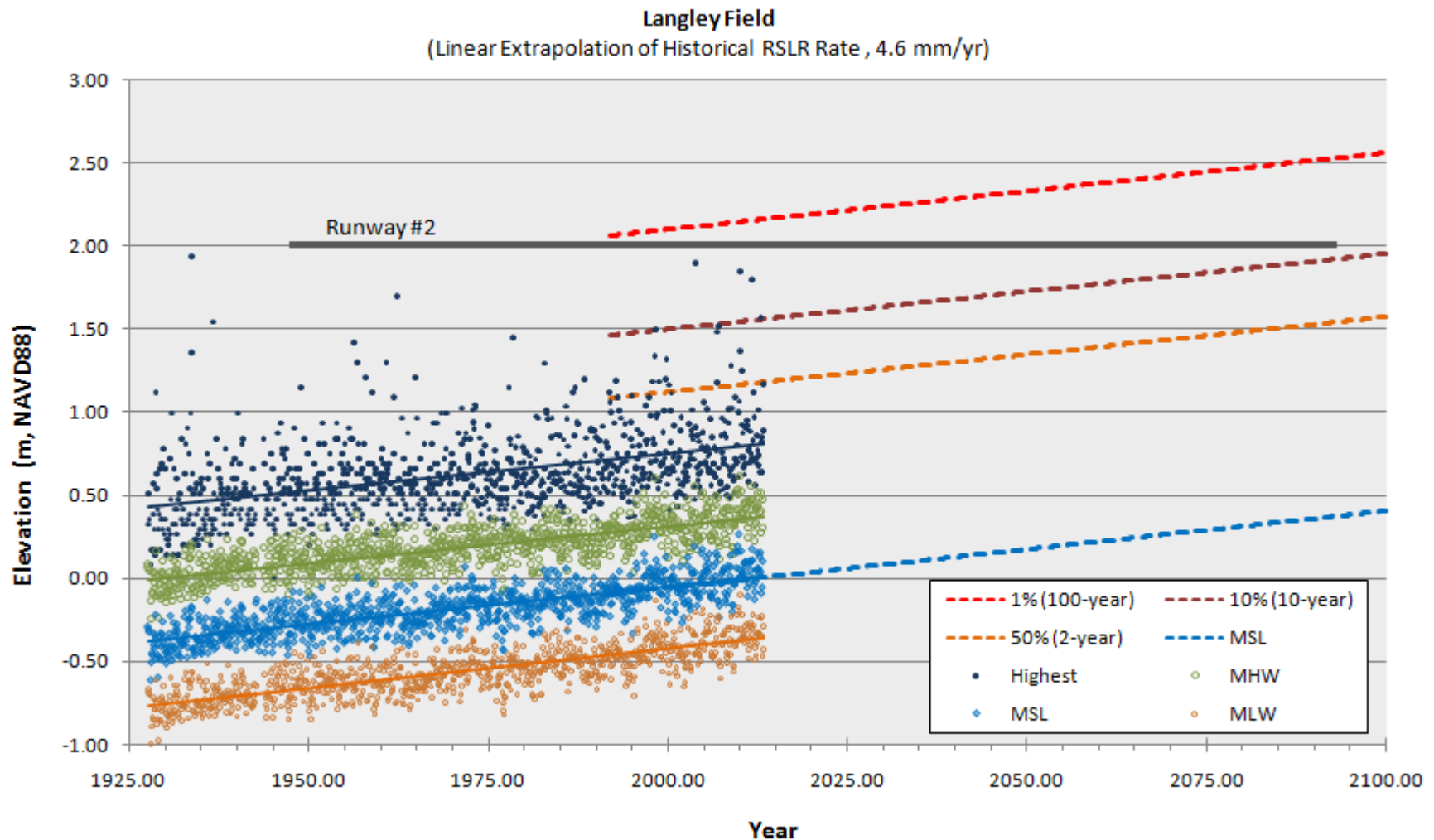


Source: Jane Smith, ERDC-CHL

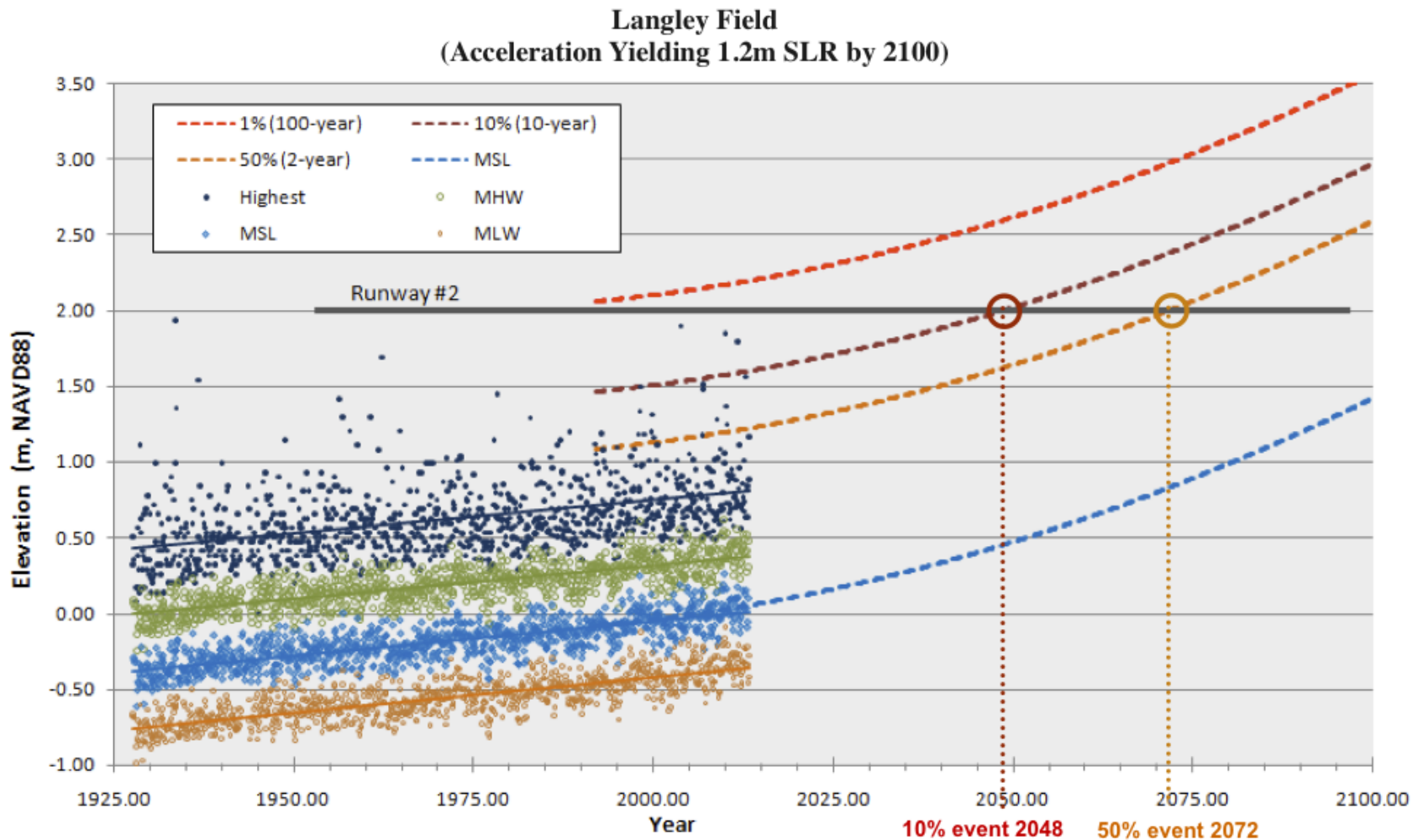
Prioritizing Screening-Level Assessment



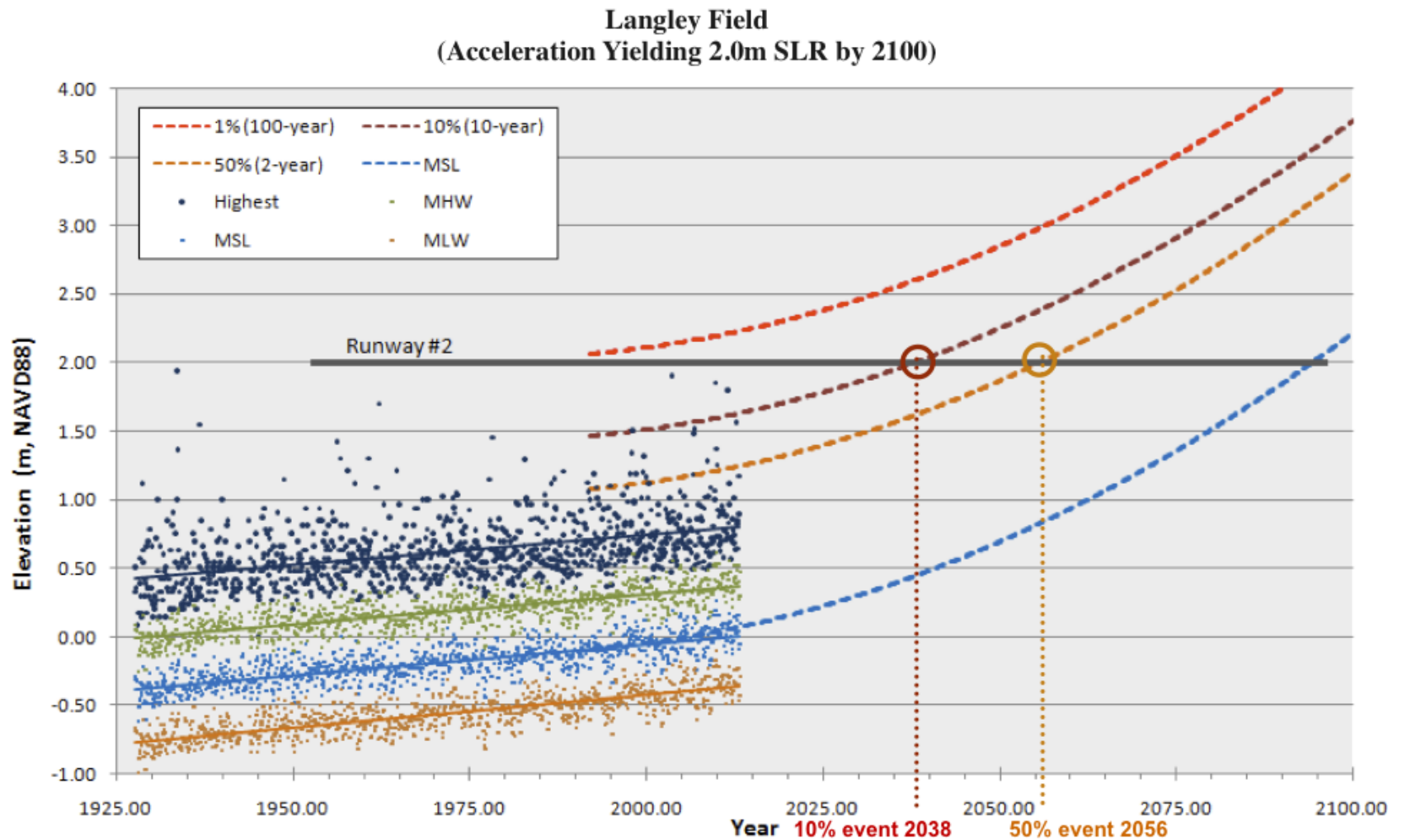
Prioritizing Screening-Level Assessment



Prioritizing Screening-Level Assessment



Prioritizing Screening-Level Assessment



Prioritizing Screening-Level Assessment

Location/ Condition	Return Period	Baseline (m NAVD88)	Future MSLR (m)			
			0.5 > 2046	1.0 > 2069	1.5 > 2087	2.0 > 2100
NBC Exposed Shoreline Total Water Level	Week	2.2	2.7	3.2	3.7	4.2
	Month	2.5	3.0	3.5	4.0	4.5
	Year	3.0	3.5	4.0	4.5	5.0
	Decade	3.5	4.0	4.5	5.0	5.5
	Century	3.7	4.2	4.7	5.2	5.7

Prioritizing Screening-Level Assessment

Long Term Scenario	Short Term Scenario	Receptor	Traning and testing lands	Buildings	Civil Infrastructure	Waterfront structures	Coastal structures	Protective Buffers
Mean SLR	Return Period	Metric	Days/Area	Cost	Cost	Days/Cost	Cost	Length
0.5 m	1 day	Estimated Risk						
	1 month							
	1 year							
	10 year							
	100 year							
1.0 m	1 day							
	1 month							
	1 year							
	10 year							
	100 year							
1.5 m	1 day							
	1 month							
	1 year							
	10 year							
	100 year							
2.0 m	1 day							
	1 month							
	1 year							
	10 year							
	100 year							

$$Risk_s = probability_s \sum vulnerabilities$$

Approaches

- Do nothing
- Move/retreat
- Flood prevention
- In-place adaptation
- Long-term planning/master planning



Design

Construction

O&M

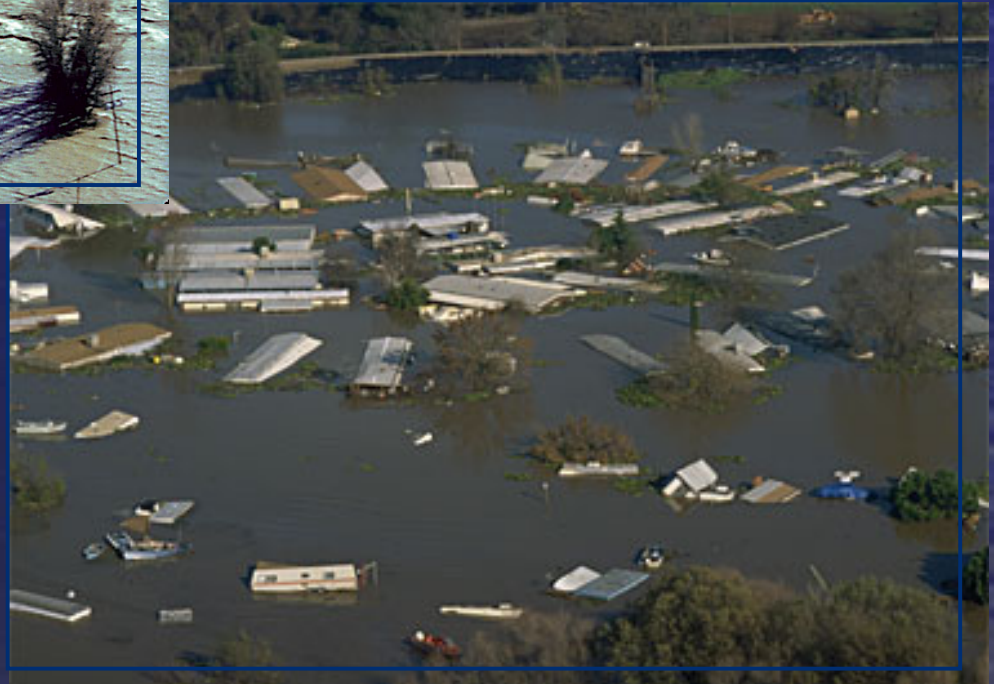
Design, Construction, O&M



Design, Construction, O&M



Design, Construction, O&M



Design, Construction, O&M



Design, Construction, O&M



Design, Construction, O&M



Design, Construction, O&M



Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program

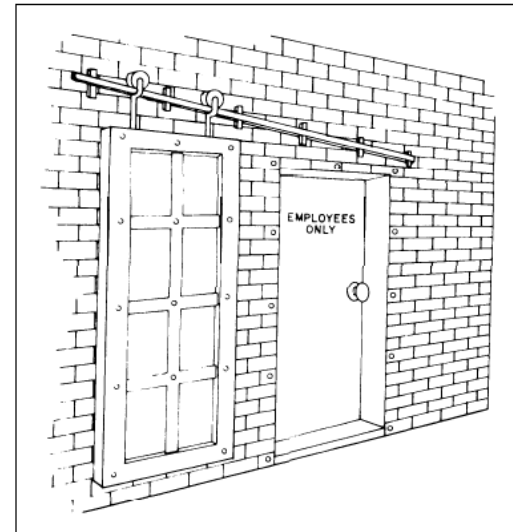


FEDERAL EMERGENCY MANAGEMENT AGENCY
MITIGATION DIRECTORATE
FEDERAL INSURANCE ADMINISTRATION

FIA-TB-7
12/93



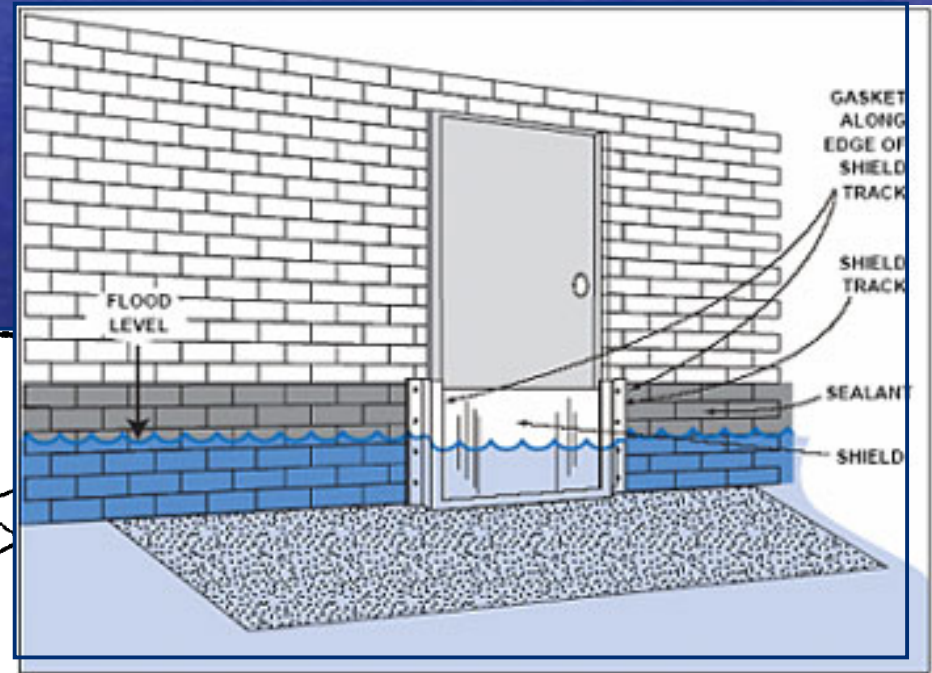
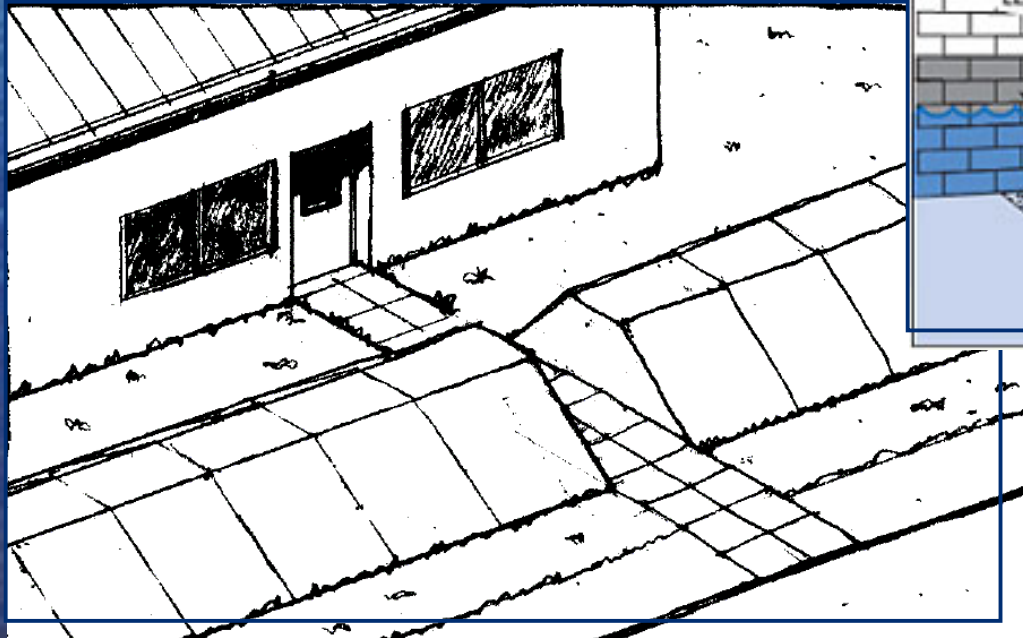
Non-Residential Floodproofing — Requirements and Certification for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program



FEDERAL EMERGENCY MANAGEMENT AGENCY
FEDERAL INSURANCE ADMINISTRATION

FIA-TB-3
4/93

Design, Construction, O&M



Design, Construction, O&M

“[Design] scenarios considered are situation-dependent and based on tolerable risk.”

Q: What does that mean and how do you apply it?

A: Three examples:

- beaches**
- levees**
- very large structures**

The background of the slide is a photograph of a vast, deep blue ocean. The water has a textured surface with small, gentle ripples. A clear, straight horizon line divides the image roughly in half, with a bright, slightly hazy sky above and the dark blue sea below. The overall tone is serene and expansive.

Maintaining Momentum

Maintaining Momentum

- **Stand-alone policy**
- **National working group (get the right people)**
- **Part of formal review process**
- **Education**
 - Internal
 - Partners
 - External
- **Perseverance**

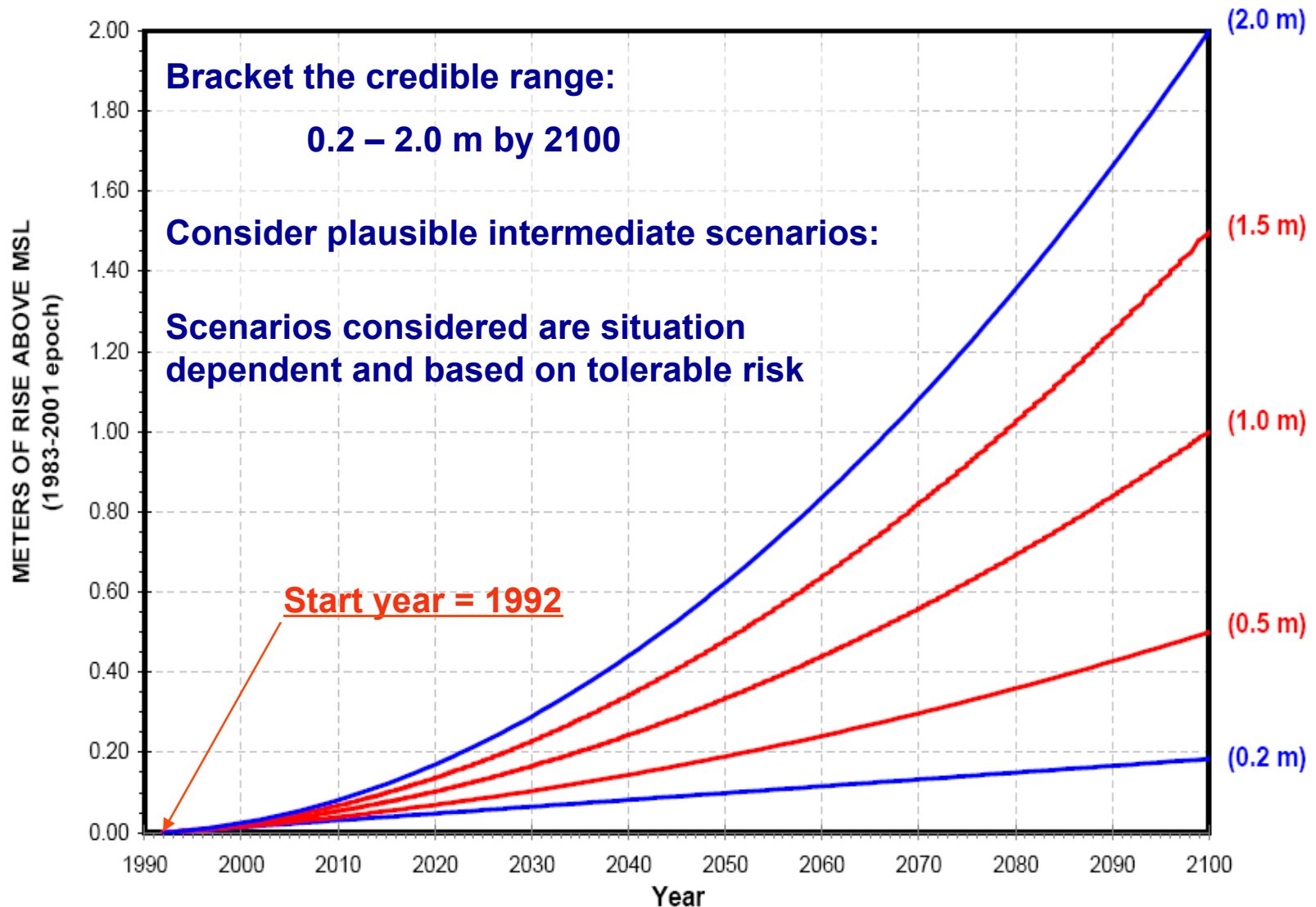
“Education is the path from cocky
ignorance to miserable uncertainty”

Mark Twain

Additional Slides in case certain questions arise

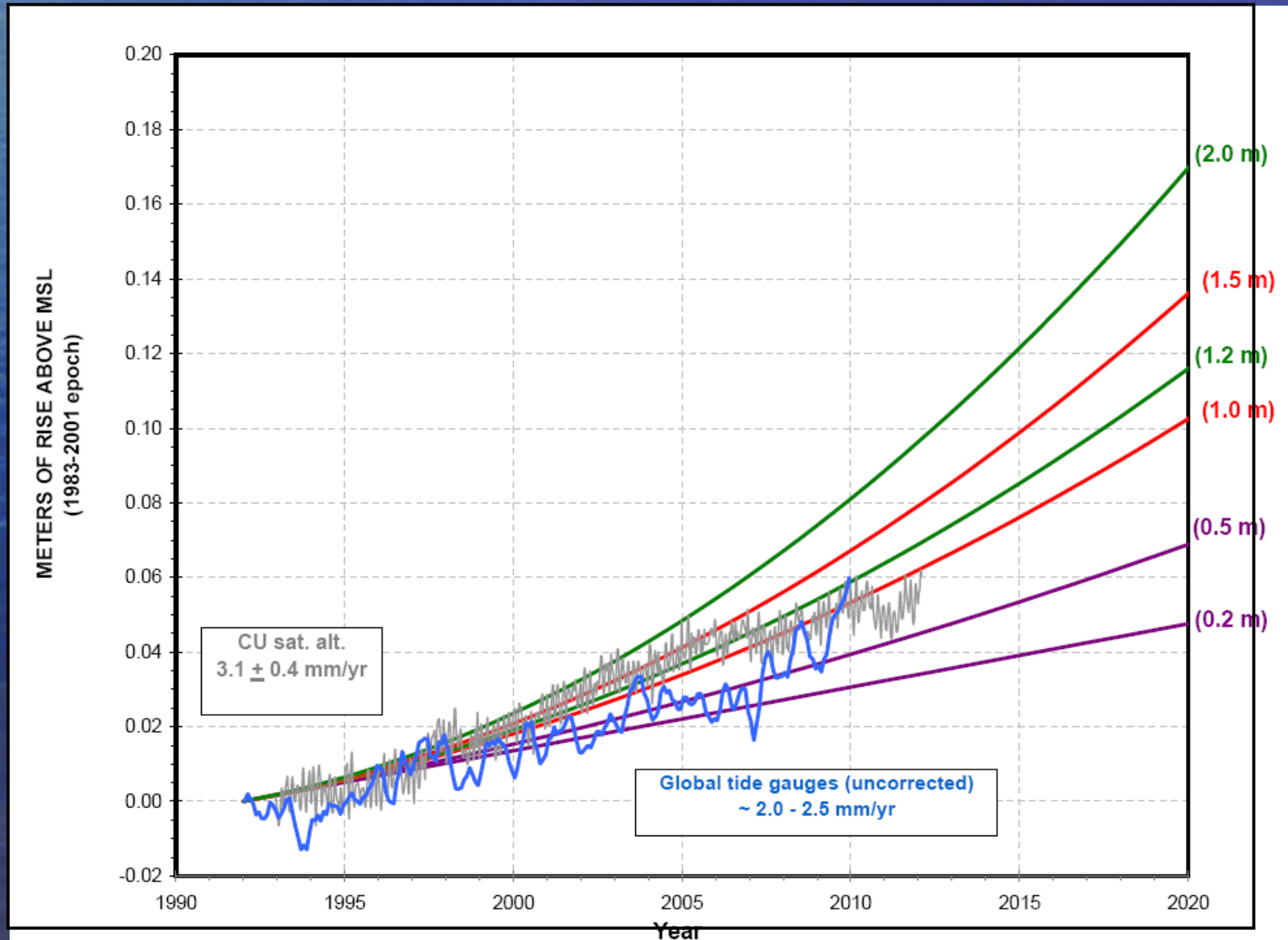
Multi-Scenario Approach

USACE SLR Scenarios



What are the Risks?

Future Projections: Where are we today?



Corps of Engineers Policy step-by-step approach

EC 1165-2-XXX
15 June 2009

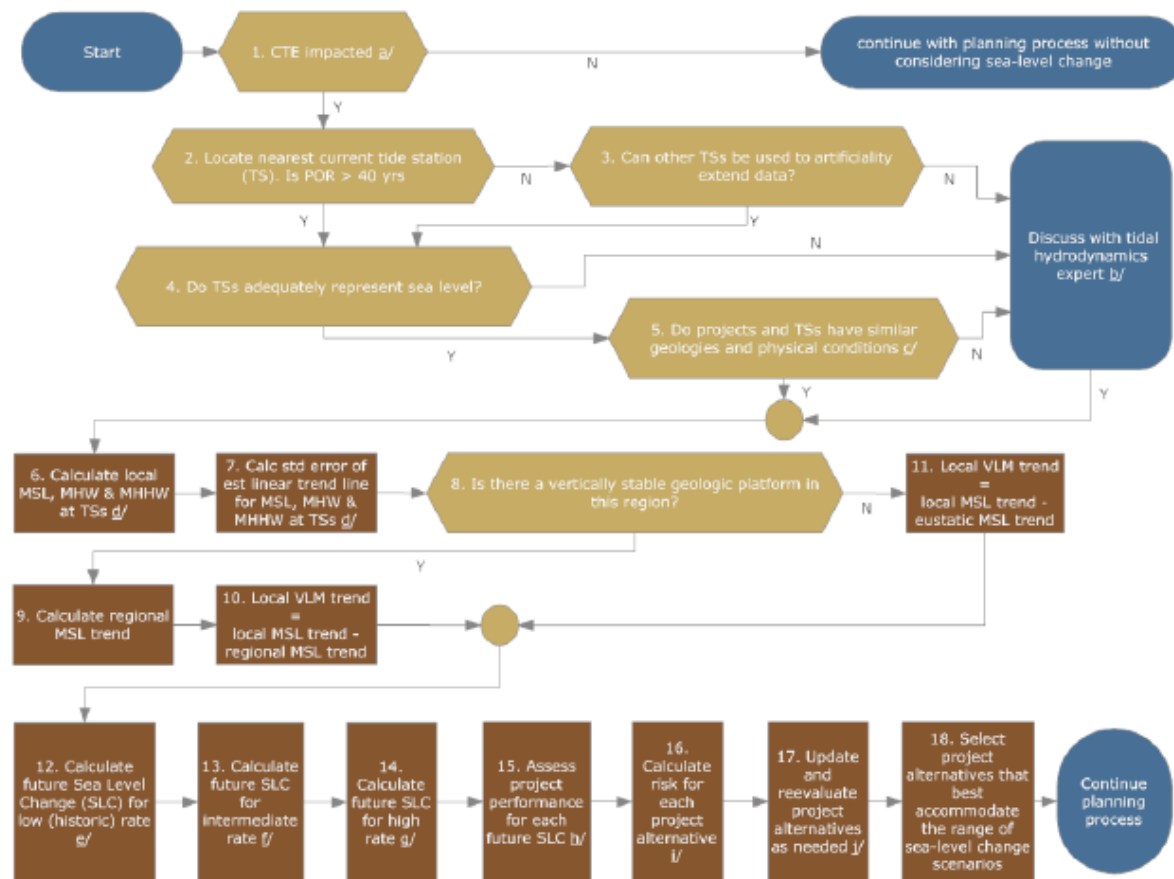
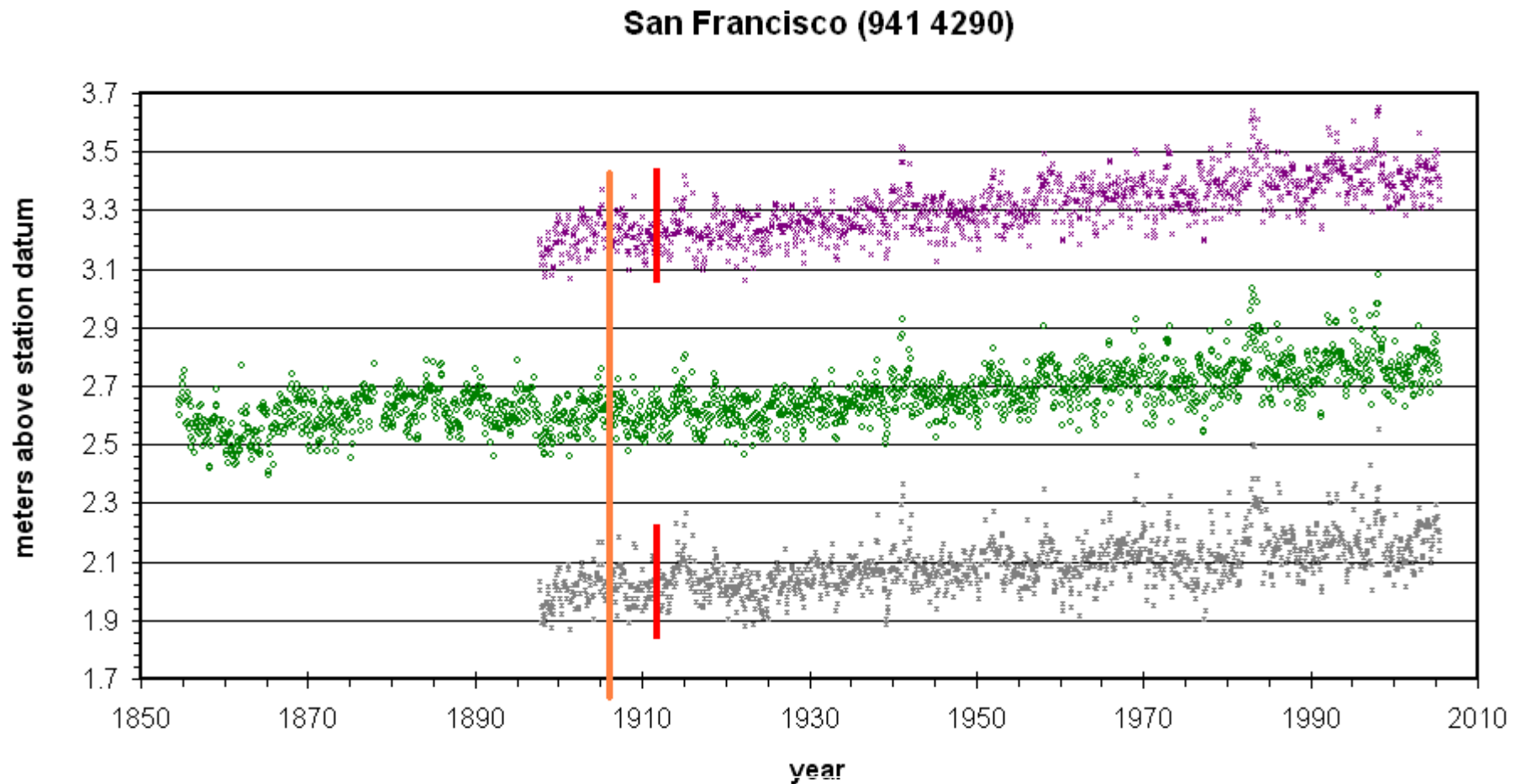


Figure C-1. Graphical illustration of process to account for changes in mean sea level.

Other Considerations



Coastal System – Infrastructure Categories

- **Training and Testing Lands** - Encompass the coastal land areas that support training and testing missions.
- **Buildings** - Includes a range of buildings that support operations and missions of the installation.
- **Waterfront Structures** - Includes a range of structures that support waterfront operations and missions of the installation.
- **Coastal Structures** - Includes a range of coastal structures whose primary purpose is to protect the shoreline and thus sustain operations and missions of the installation.
- **Civil Infrastructure** - Describes a broad category of built infrastructure that is critical to the day-to-day operations and mission of the installation.
- **Protective Buffers** - Classified as non-engineered coastal areas that provide a natural means of protection for coastal installations from changes in sea level.